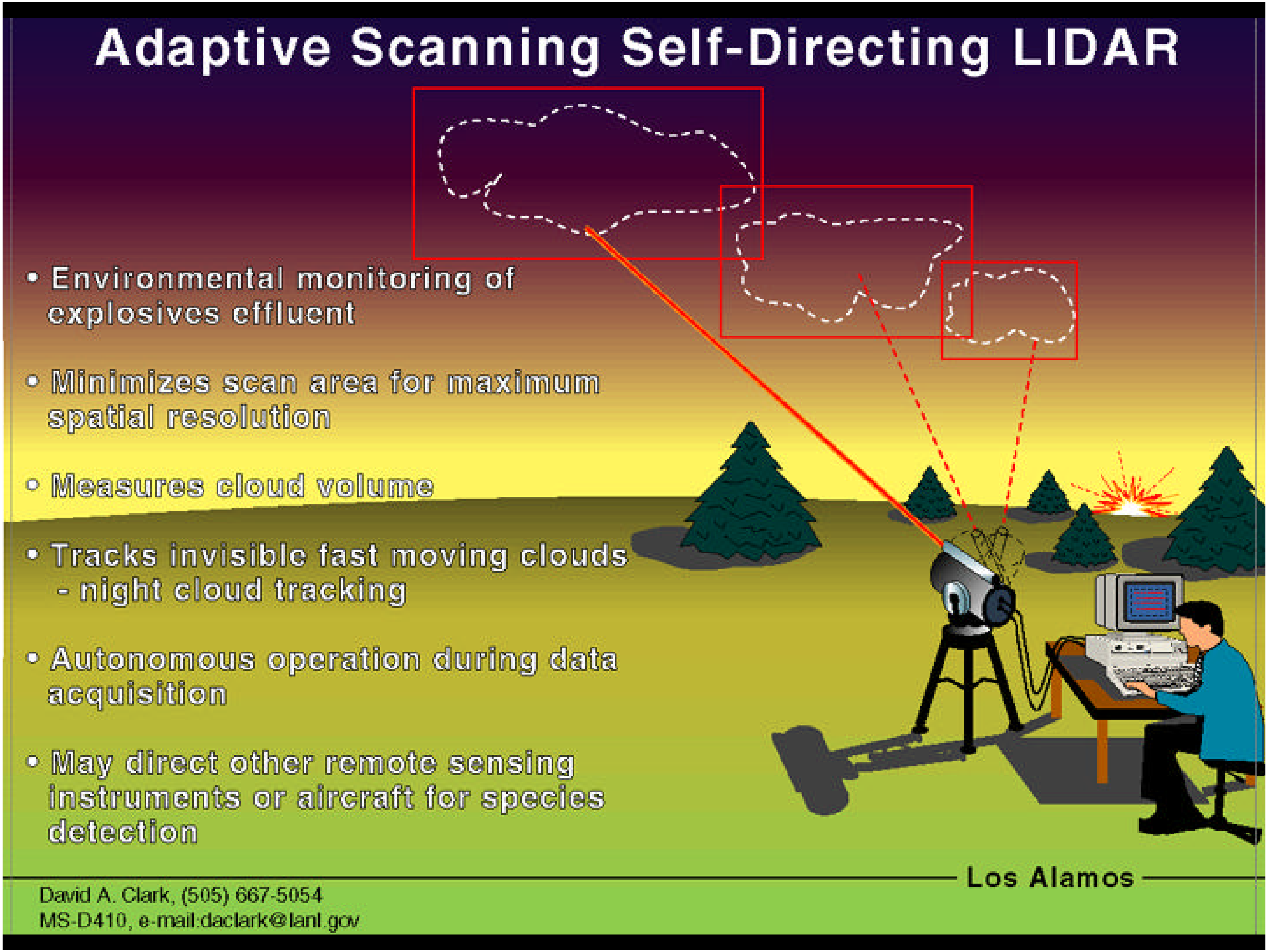
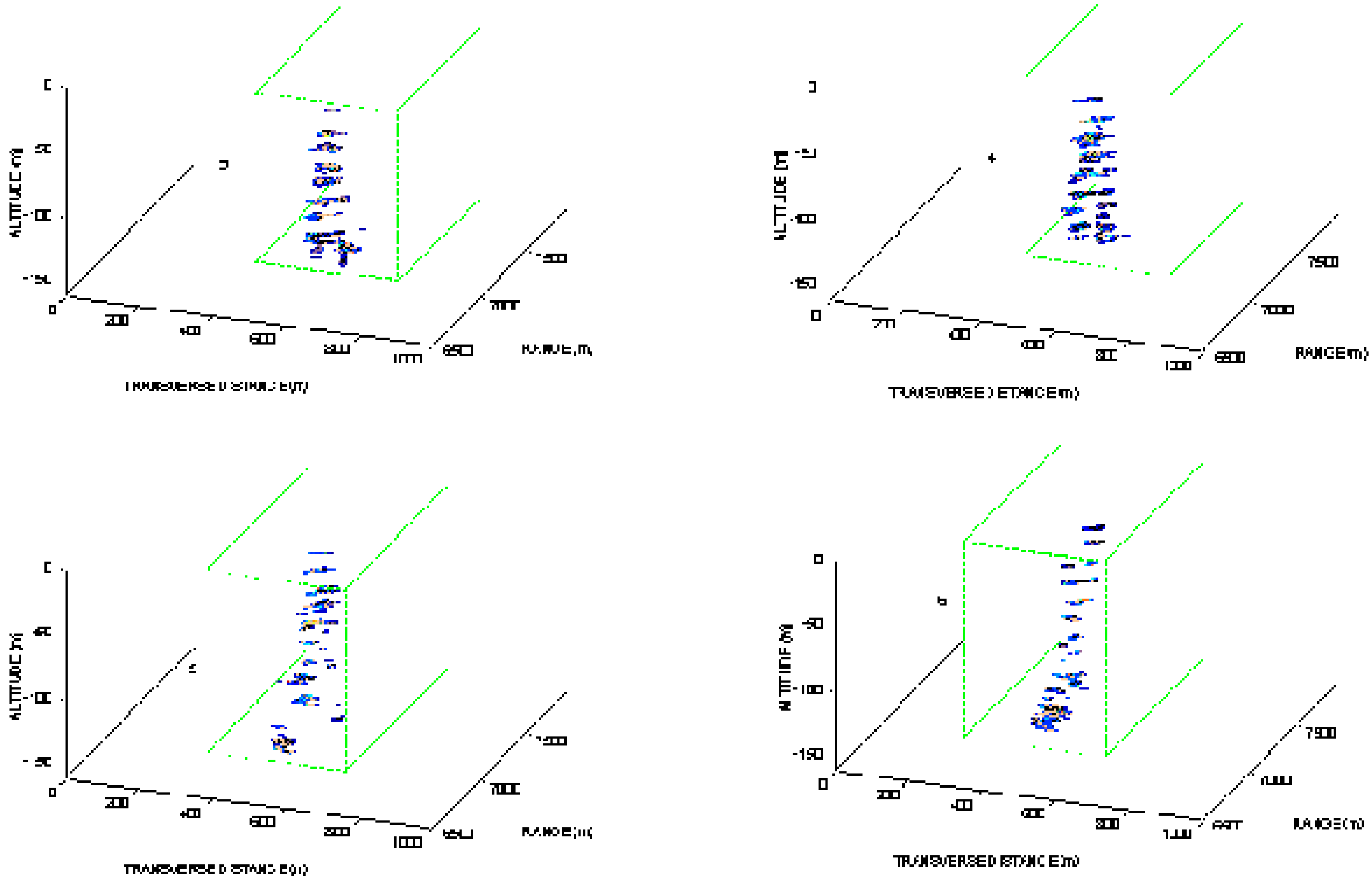
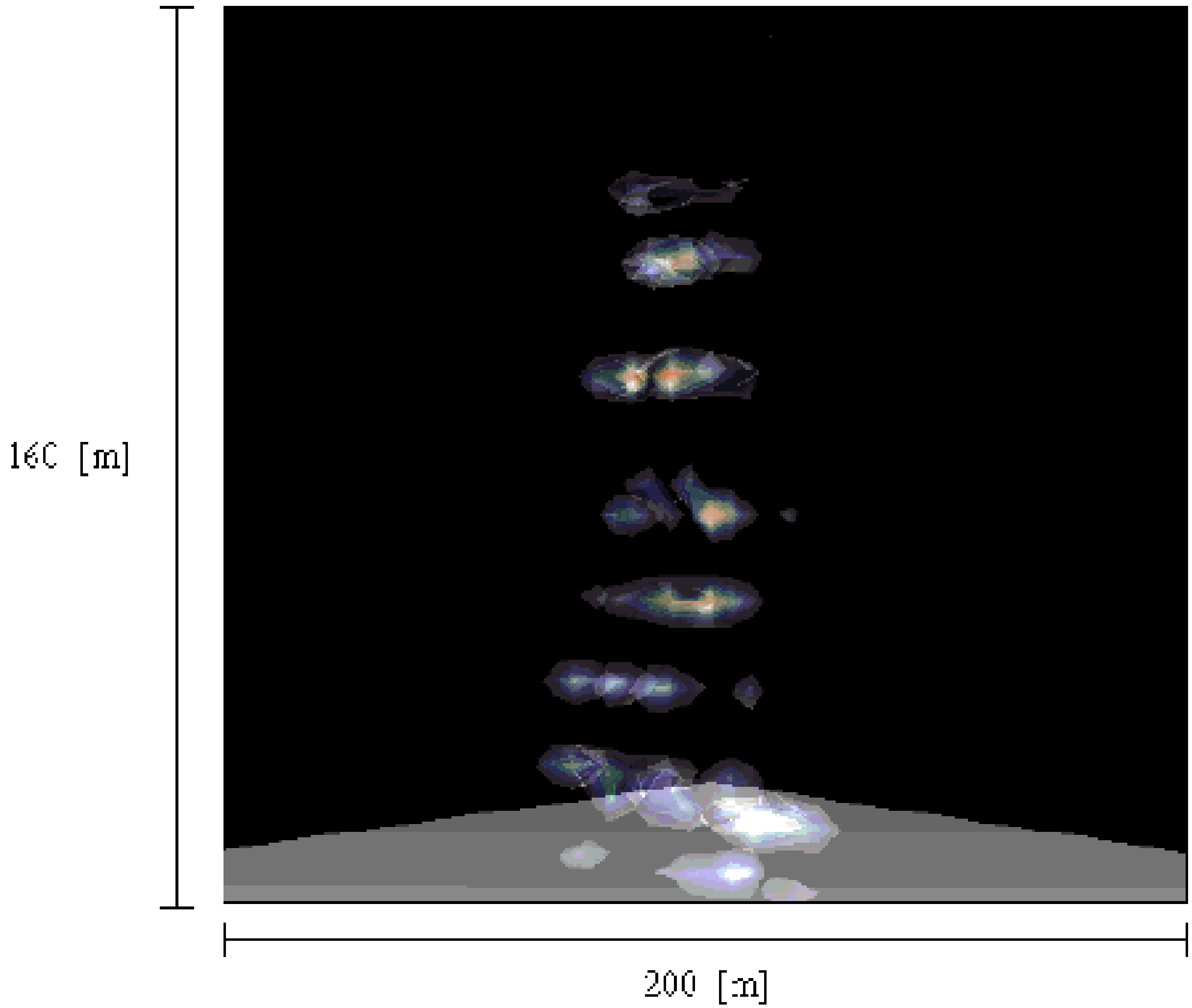

Adaptive Scanning Self-Directing LIDAR
• Environmental monitoring of explosives effluent
• Minimizes scan area for maximum spatial resolution
• Measures cloud volume
• Tracks invisible fast moving clouds - night cloud tracking
• Autonomous operation during data acquisition
• May direct other remote sensing instruments or aircraft for species detection
Los Alamos
David A. Clark, (505) 667-5054
MS-D410, e-mail:daclark@lanl.gov

TRACKING OF DEBRIS CLOUD WITH ADAPTIVE SCANNING LIDAR CONTROL SYSTEM



Time between individual scan windows is less than 40 sec.

3D MAPPING OF INVISIBLE PLUME USING LIDAR



KALPAK A. DIGHE
Nonproliferation & International Security

Debris Cloud Volume and Aerosol Content for Two Explosive Tests

Experiment 1

Frame Number	Volume (10^6-m^3)	Error (10^6-m^3)	Content (10^6-m^3)
1	*		
2	0.39	0.019	23
3	0.88	0.020	30
4	1.4	0.025	32
5	2.0	0.038	31
6	2.7	0.043	37
7	3.3	0.067	40
8	3.9	0.084	43
9	2.8	0.11	25

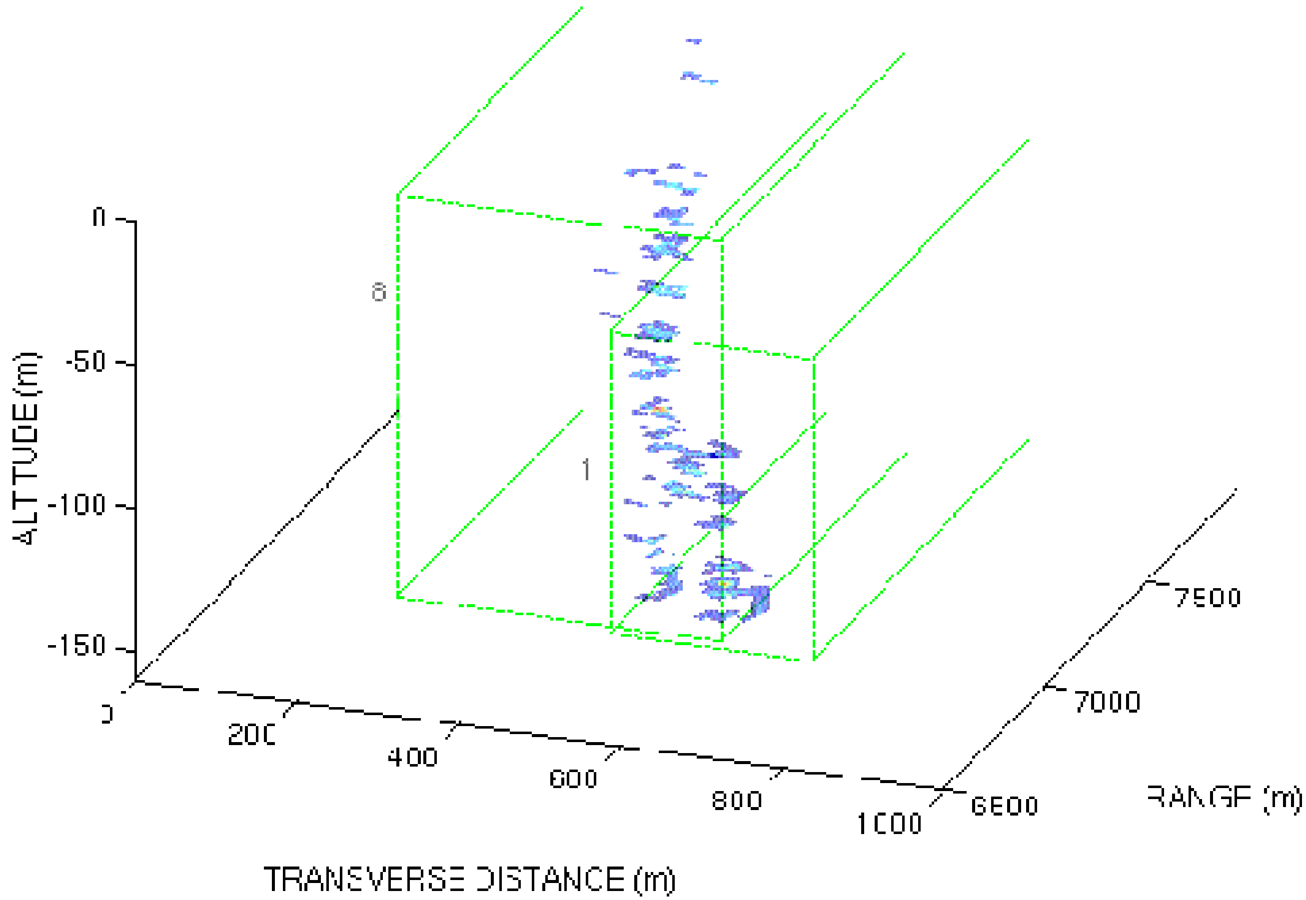
* First data set was lost

Experiment 2

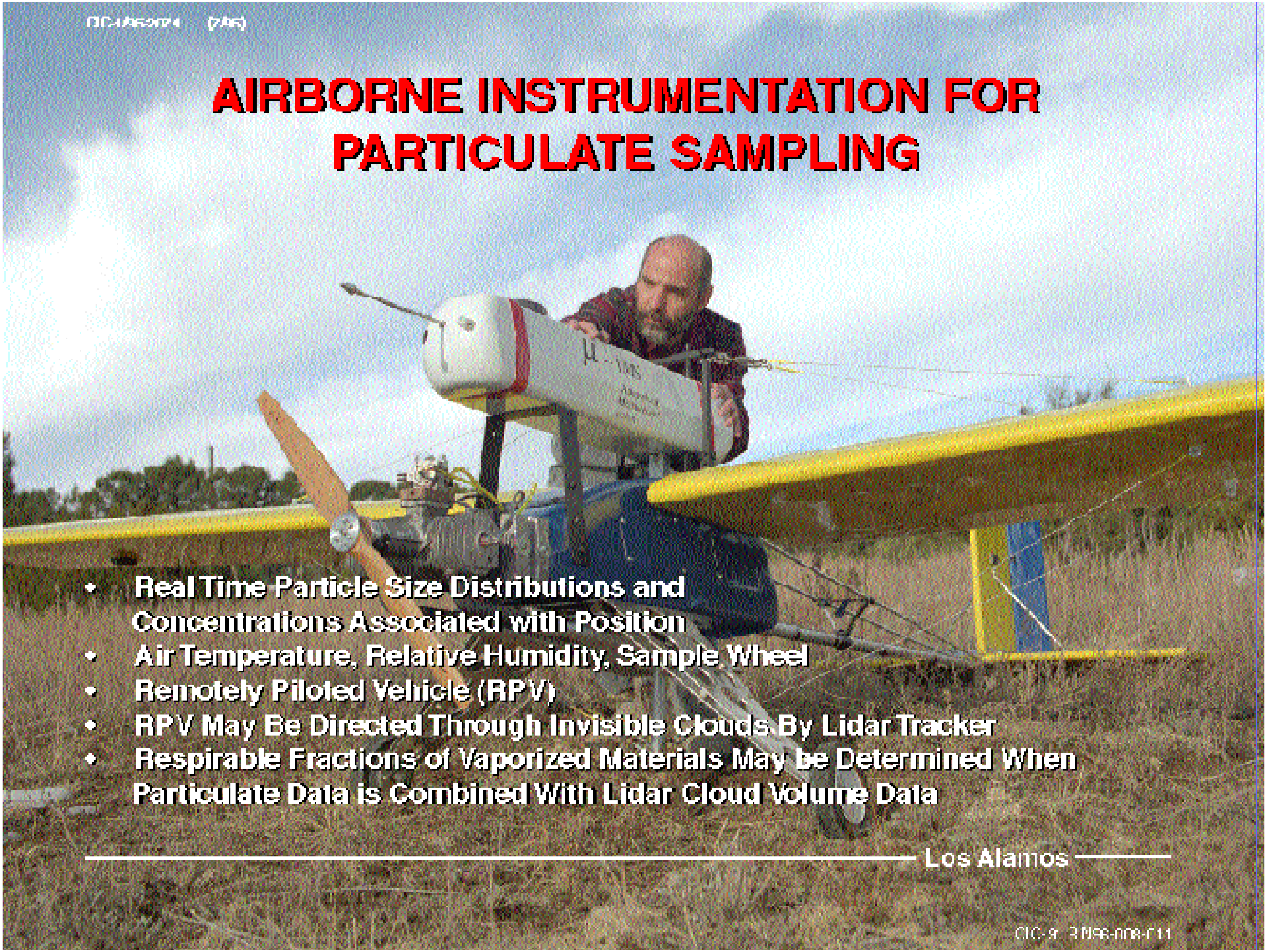
Frame Number	Volume (10^6-m^3)	Error (10^6-m^3)	Content (10^6-m^3)
1	0.31	0.009	27
2	0.52	0.010	42
3	0.70	0.014	58
4	1.0	0.018	72
5	1.4	0.020	91
6	1.9	0.026	76
7	2.9	0.037	76
8	3.8	0.038	48
9	5.1	0.067	45
10	5.4	0.084	22
11	2.3	0.059	10

Results of preliminary numeric analysis of cloud measurement data from two explosive tests. Both data sets show a steady increasing cloud volume before tracking is lost. Material content in the first data set exhibits a small plateau. Late time development of a second cloud (clearly shown on individual data frames) pushes the material content up to a peak of 43. Material content of the second cloud peaks earlier (at 91) as significant portions of the cloud are drifting out of view.

TWO SCANS OF AN INVISIBLE DEBRIS CLOUD



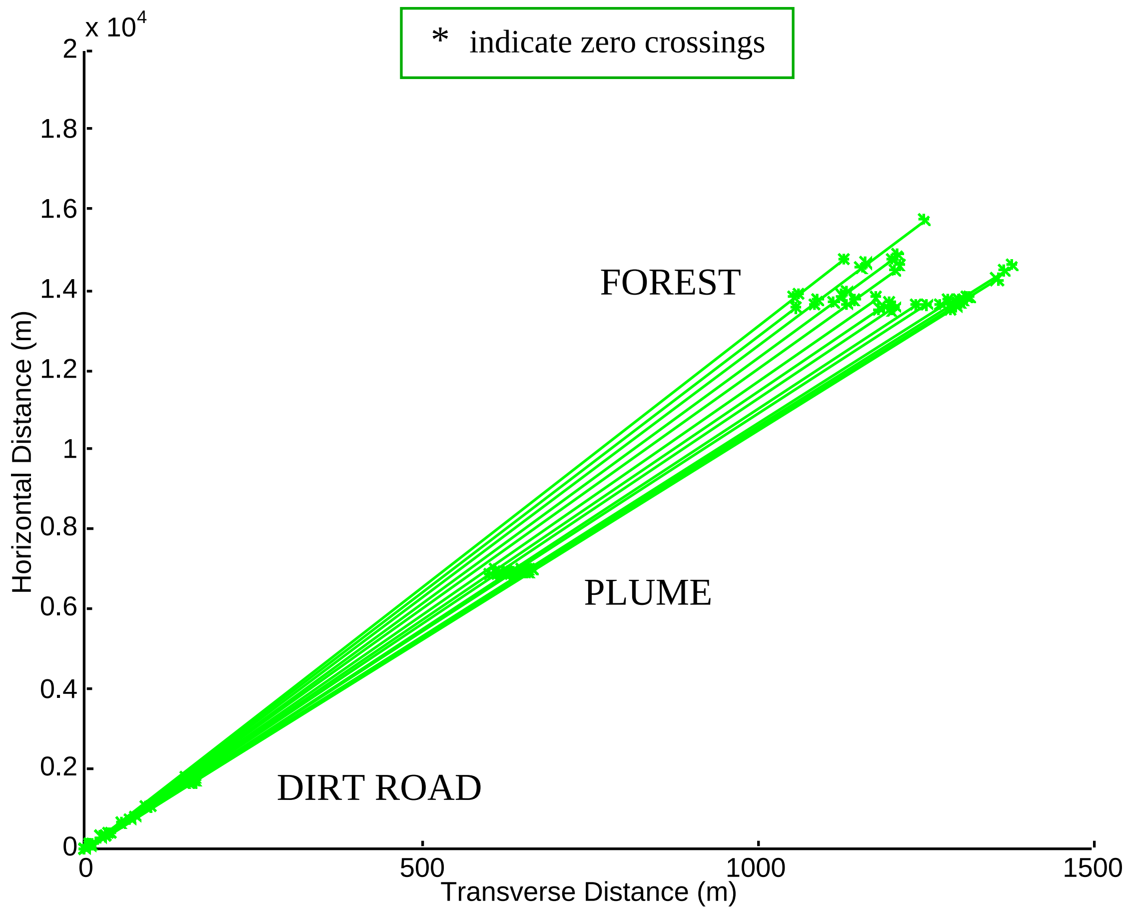
Three dimensional rendering of the debris cloud resulting from a 1-kg detonation. The outlined boxes represent scan dimensions of windows 1 and 8 as automatically set by the lidar control system. Time between the two scans is approximately three minutes.


AIRBORNE INSTRUMENTATION FOR PARTICULATE SAMPLING
• Real Time Particle Size Distributions and Concentrations Associated with Position
• Air Temperature, Relative Humidity, Sample Wheel
• Remotely Piloted Vehicle (RPV)
• RPV May Be Directed Through Invisible Clouds By Lidar Tracker
• Respirable Fractions of Vaporized Materials May be Determined When Particulate Data is Combined With Lidar Cloud Volume Data
Los Alamos

LANL MOBILE ELASTIC LIDAR SYSTEM

The Self-Directing Adaptive Scanning LIDAR control system was tested on the LANL Mobile Elastic Lidar System shown here. This platform was chosen for convenience as the control system techniques will work on any agile computer controlled scanning lidar. The Mobile Elastic Lidar System has a Continuum Nd:YAG that operates at 1064-nm, 50-Hz, with 500mJ pulse energy. An avalanche photo-diode (APD) serves as the detector. Data acquisition and control hardware includes a 66 MHz 486 processor and a CAMAC based digitizer system.

AERIAL VIEW OF LIDAR BEAM AS IT SCANS ACROSS TERRAIN



ADAPTIVE SCANNING
SELF-DIRECTING LIDAR

- Environmental Monitoring of Explosives Effluent
- Minimizes Scan Area for Maximum Resolution
- Measures Cloud Volume
- Tracks Invisible Fast Moving Clouds
  - night cloud tracking
- Autonomous Operation During Data Acquisition
- May Direct Other Remote Sensing Instruments or Aircraft for Species Detection

ABSTRACT

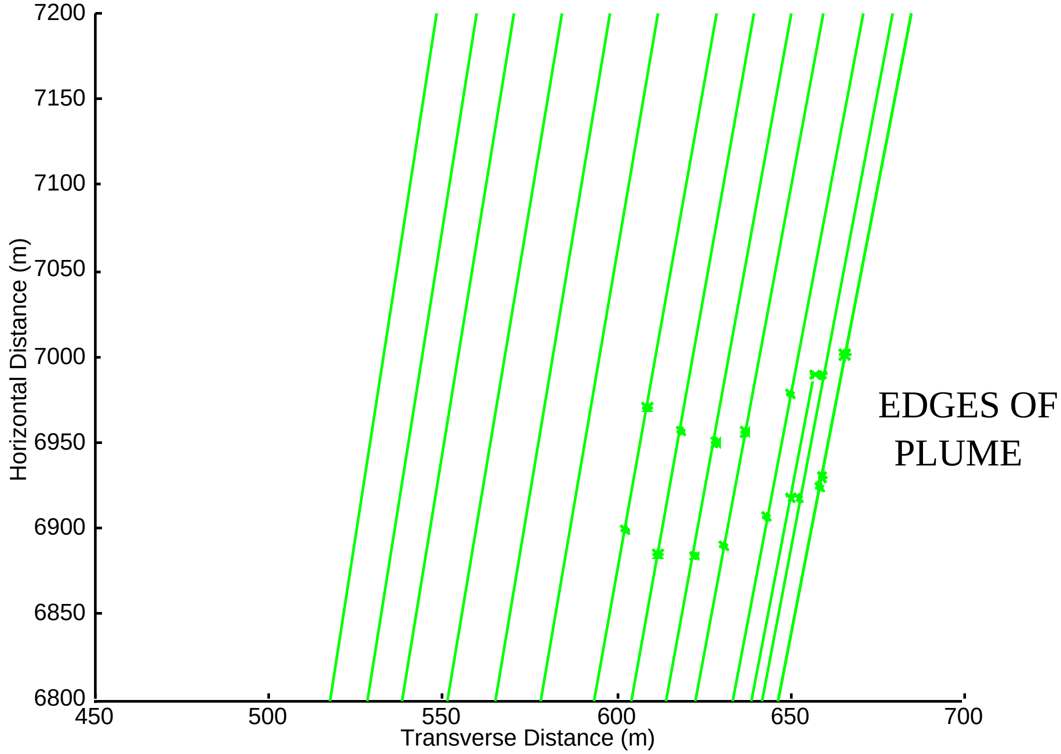
A new adaptive scanning self-directing elastic backscatter lidar which automatically tracks and maps isolated clouds has been used to gather cloud data from two above ground explosive tests. Accurate cloud volume, density distribution, and track information was obtained on small, fast moving, low density, invisible debris clouds. The new lidar control system utilizes the backscatter signal itself to direct the lidar toward the cloud and minimize the scan dimensions. As the cloud evolves, both spatially and temporally, the system dynamically re-adjusts the scan to cover the entire volume of the cloud. Confinement of the scan region to the immediate vicinity of the cloud allows more scans in a given time for high resolution information during the cloud evolution.

Ultimately, the lidar will be used in conjunction with an airborne remotely piloted vehicle (RPV) to measure the total mass of specific cloud materials. Particle concentration and other measurements from the RPV will be combined with cloud volume and density information from the lidar to determine constituent mass. Real time lidar cloud position information will direct the RPV through the cloud, even if it is not visible to the ground based pilot.

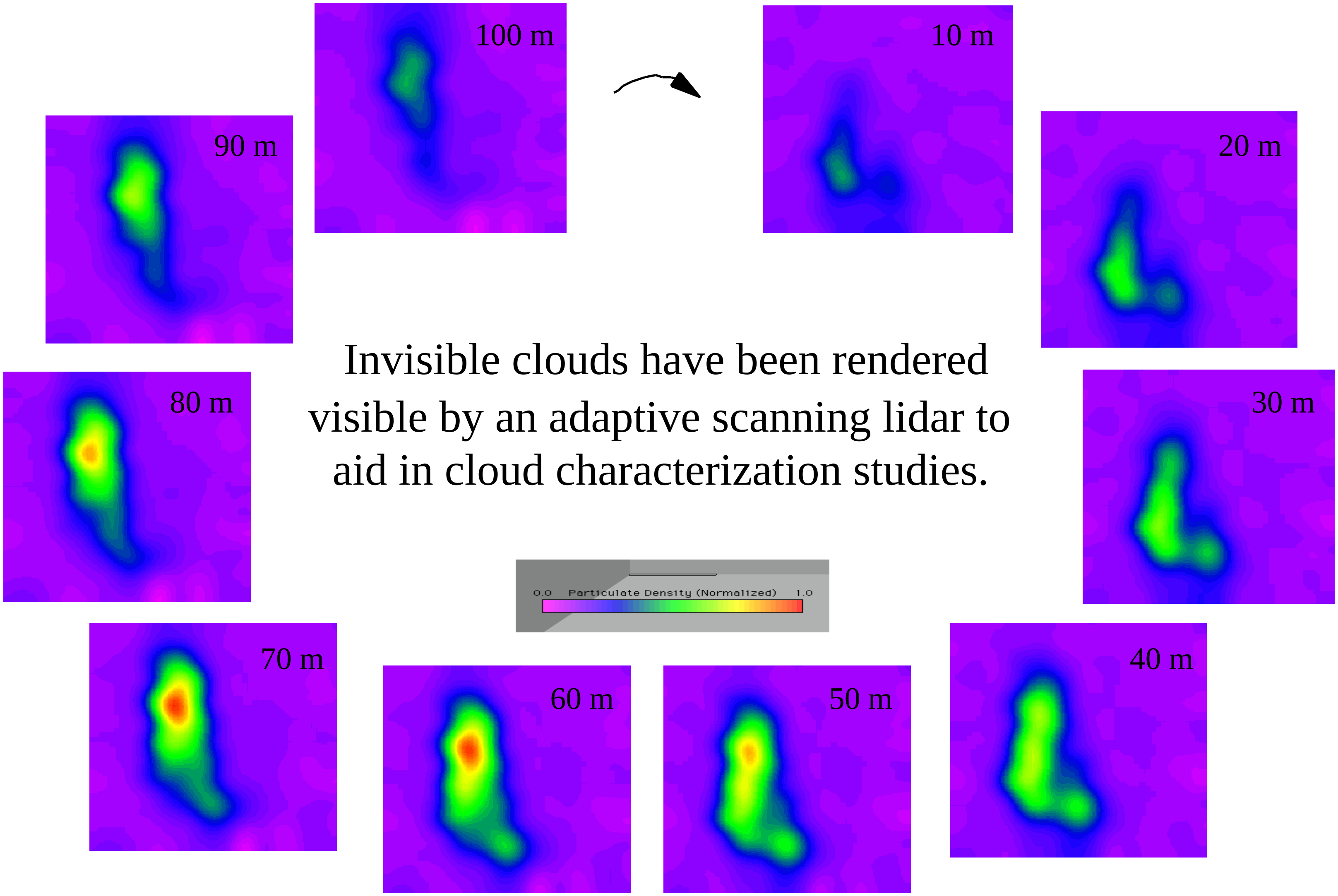
In the future, this cloud tracking lidar can direct other remote sensing devices for species identification. Such devices, which often require long integration times, would then be able to gather data on small, fast moving, subvisible, isolated clouds.

DETECTION OF ZERO CROSSINGS USING ADAPTIVE PROCESSING ALGORITHMS

- fast, since it can be implemented in hardware
- only a handful of points are passed on for further analysis

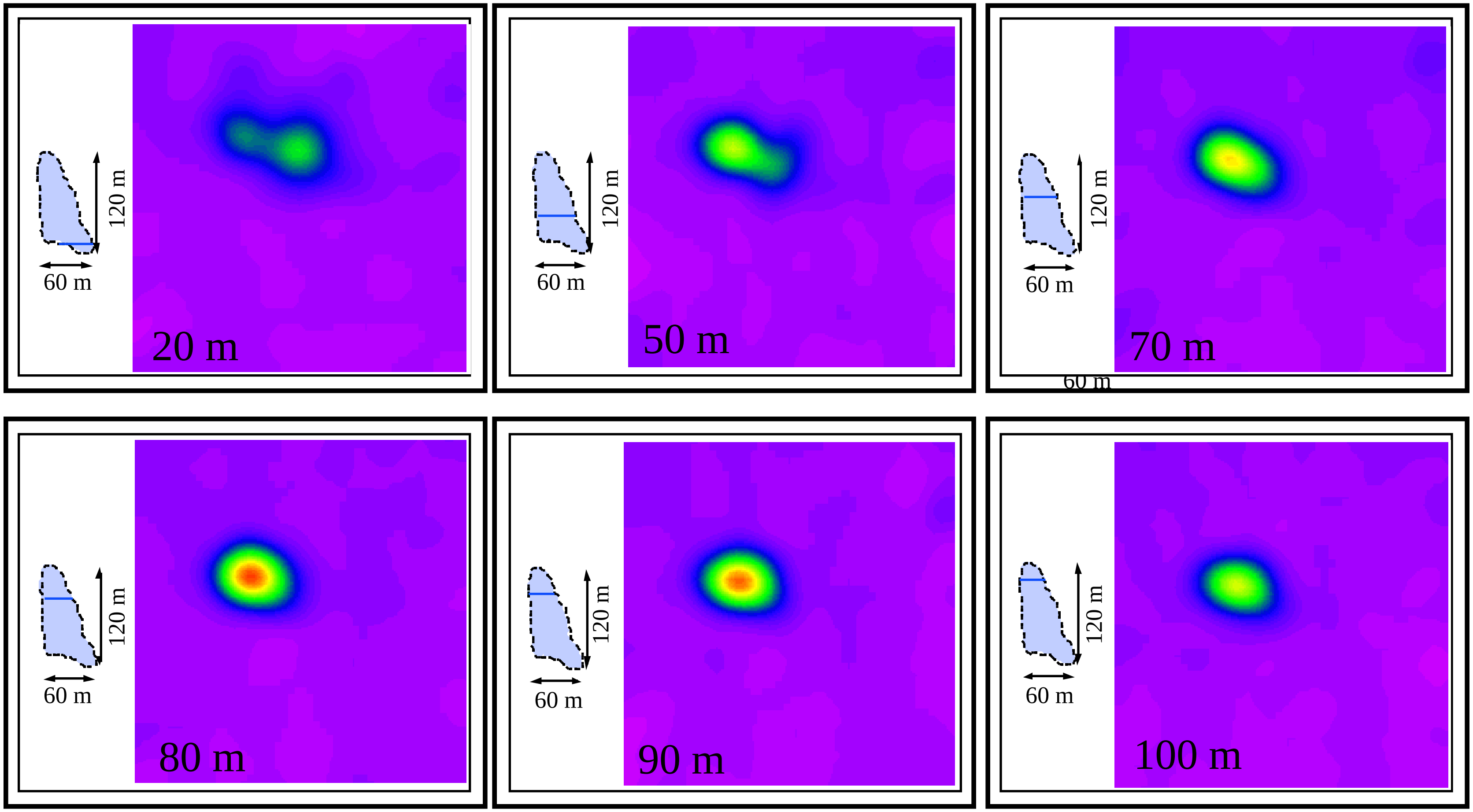


VERTICAL CROSS-SECTIONAL VIEWS OF DEBRIS CLOUD



Invisible clouds have been rendered visible by an adaptive scanning lidar to aid in cloud characterization studies.

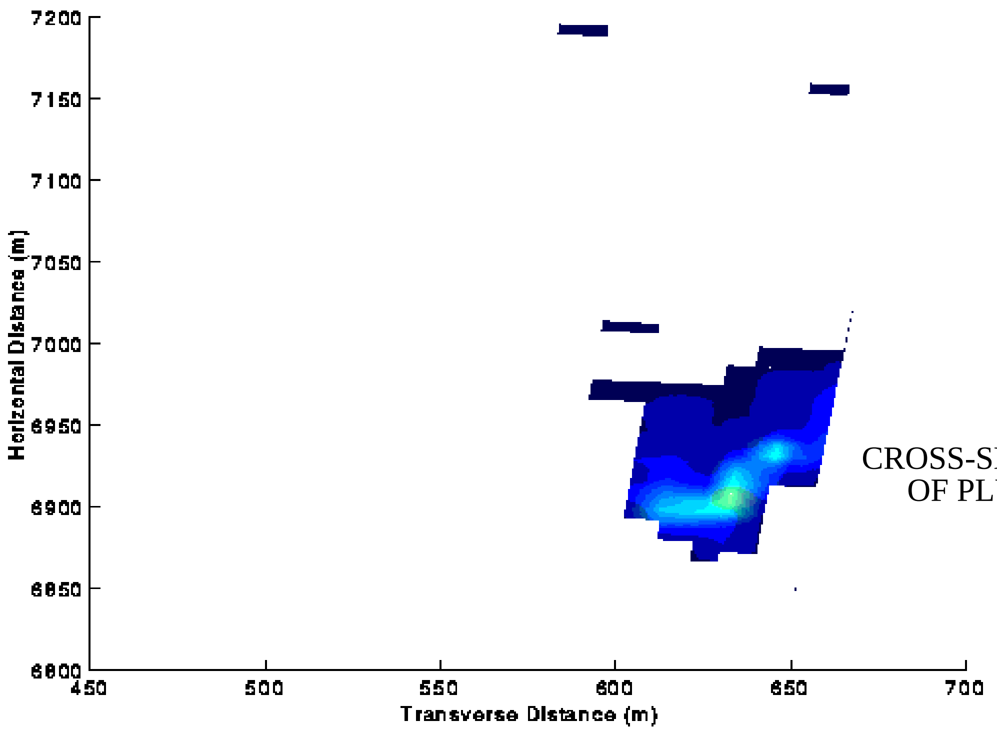
HORIZONTAL CROSS-SECTIONS OF INVISIBLE DEBRIS CLOUD RENDERED VISIBLE BY LIDAR



For studies involved with characterization of debris clouds, such as mapping particulate density distributions within a cloud, the cross-sectional views shown above provide an invaluable tool. Without an adaptive scanning lidar, these debris clouds would have been undetected, unless one had prior knowledge of their exact locations. (These figures were obtained from a 1 kg detonation of conventional exposives.)

ANALYSIS OF LIDAR DATA USING CONVENTIONAL TECHNIQUES

- cannot be implemented in hardware; must be done off-line
- slow and laborious, since all data must be processed



CROSS-SECTION
OF PLUME